



FPGA based Directional control of MTB cells For Bioengineering Applications

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Abstract

We designed a circuit using the logic elements of FPGA for controlling MTB. The circuit is connected to a mesh of coil, where a path of magnetic field is created using FPGA. The MTB's motility is controlled in a particular direction along this path. Then the bacterial invasion is studied highlighting how the MTB cells and mutant cells interact using the FPGA based controller.

Introduction

Magnetotactic bacteria (or MTB) are a group of bacteria that orient along the magnetic field lines of Earth's magnetic field. These bacteria have organelles called magnetosomes that contain magnetic crystals, which aid in aligning with the magnetic field. MTB's can be used in various applications like MEMS, Micro Total Analysis Systems and lab-on-chip.

Magnetotactic bacteria can be guided along a predefined path by controlling the magnetic field, these bacteria can sense the magnetic field and can align itself towards the field to move towards the North Pole. By changing the magnetic field along a predetermined path, these bacteria can be guided. This property can be adventurous for invasion of MTB in the mutant cells.

Materials and Methods

We used a 32 AWG coil of thickness 50 micrometer to make a tiny mesh that creates a path for the bacteria by creating the magnetic field. Altera DE2 board is used to provide the current supply for the coil and also to change the direction and the strength of magnetic field. The MTB bacteria is used for the experiment.

Configuring FPGA Controller

FPGAs contain an array of programmable logic blocks and an hierarchy of configurable interconnects that connects the logic block together. The device is configured to pass current through the 32 AWG coil. The current through the coil generates the magnetic field. The device is configured to vary the direction of current flowing through the coil, which changes the magnetic field direction.

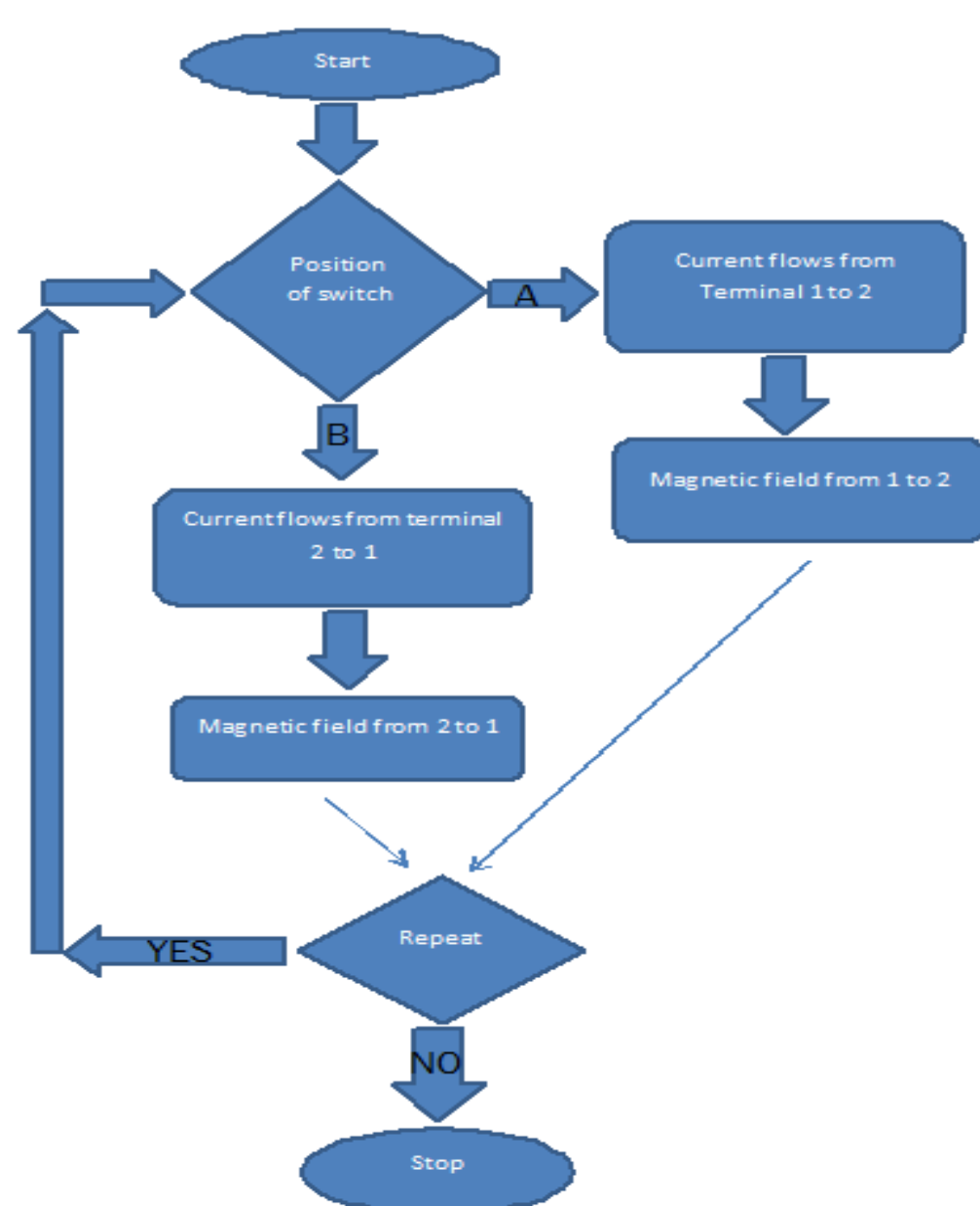


Fig1 Algorithm

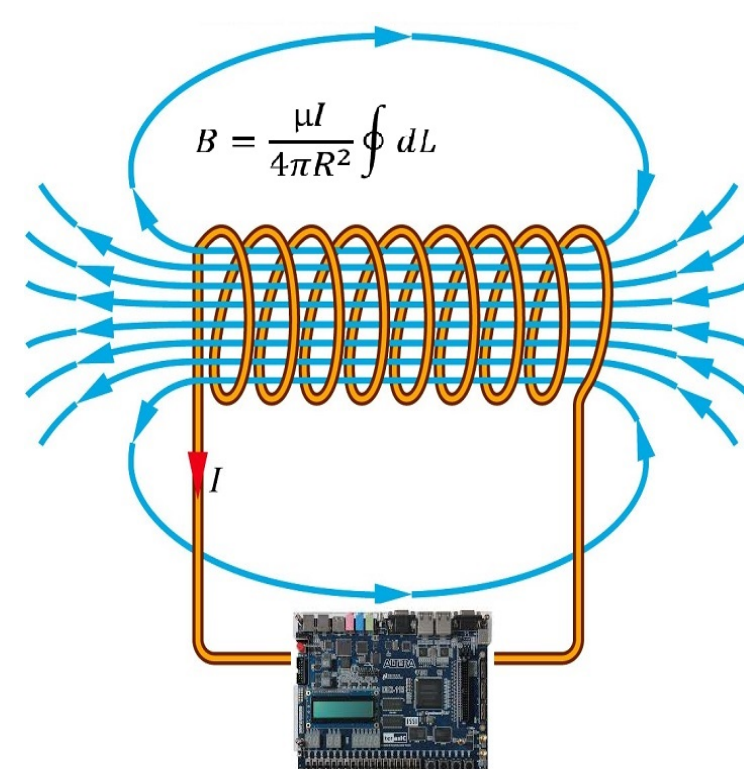


Fig2 FPGA controller setup

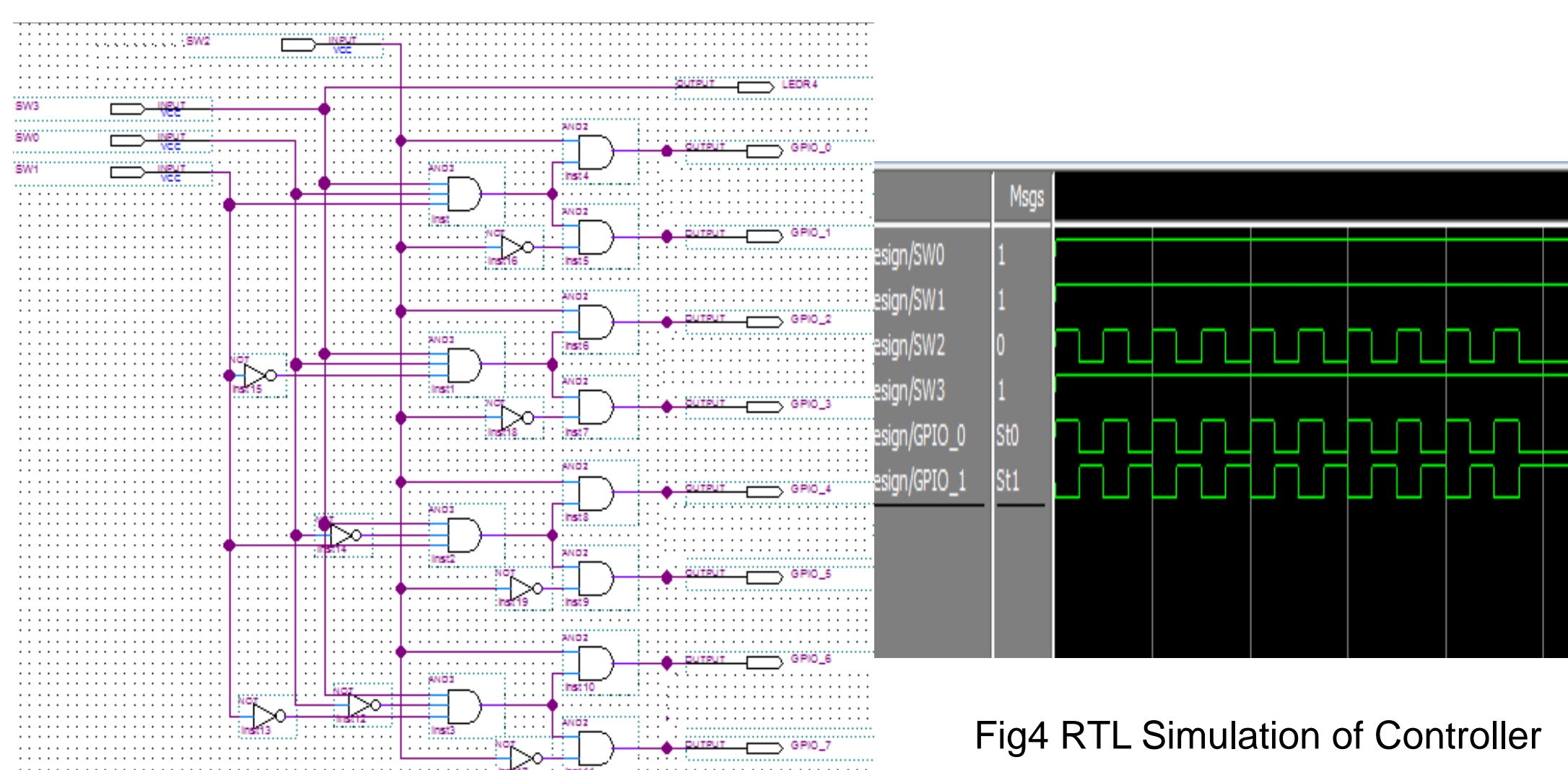


Fig3 Controller Logic

Fig4 RTL Simulation of Controller

Current Work

The MTB bacteria contains the magnetosomes, intracellular membrane bound crystals of iron mineral which consists of either magnetite, that are attracted towards the magnetic field. The current works in our experiments are:

- Invasion of bacteria in the tumor cells and quantify the number of MTB cells that invaded.
- The quality of tumor cells after invasion.
- The quantity of MTB cells that are alive.

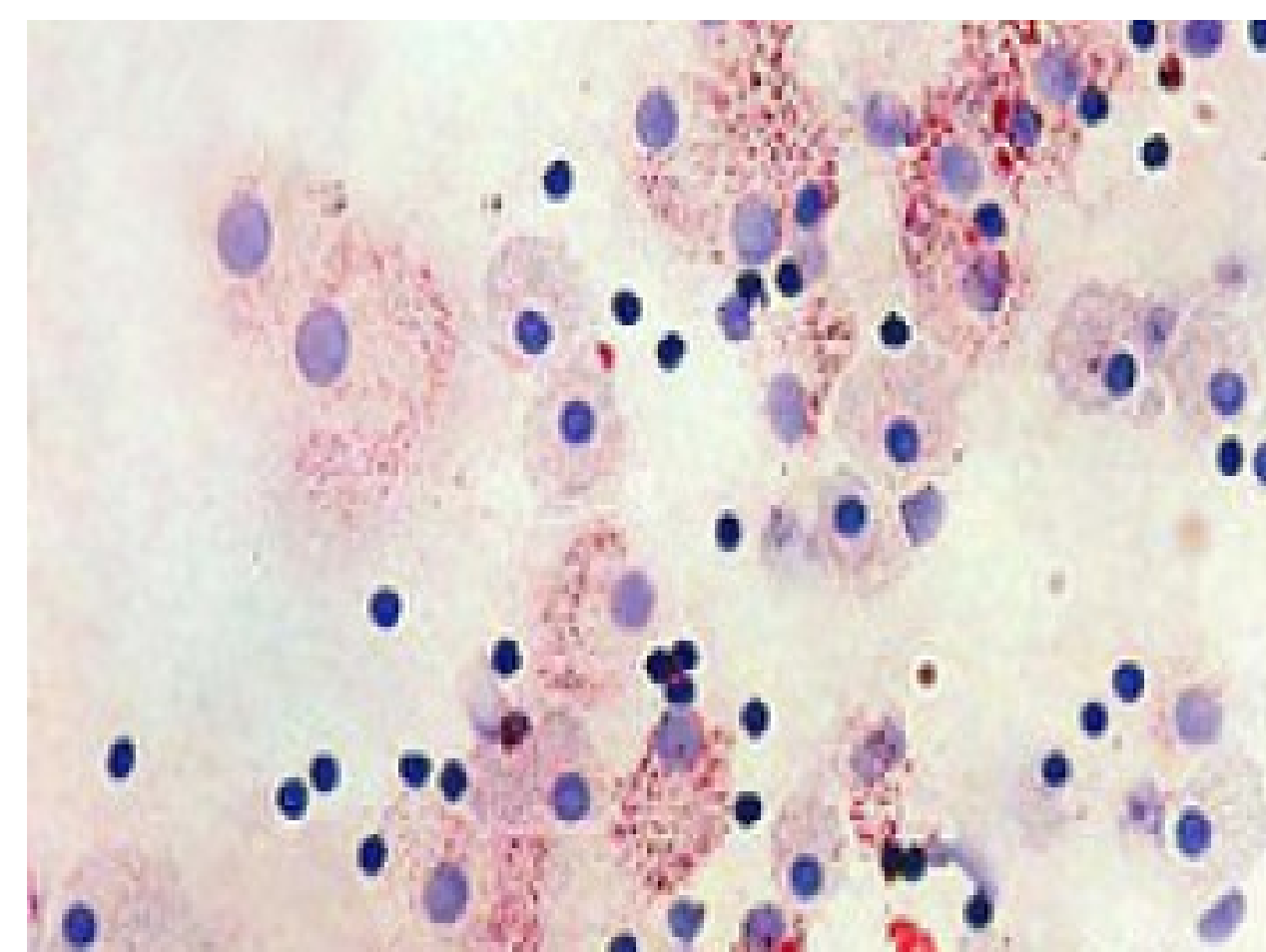


Fig5 Bacteria attacking the mutant cells.[4]

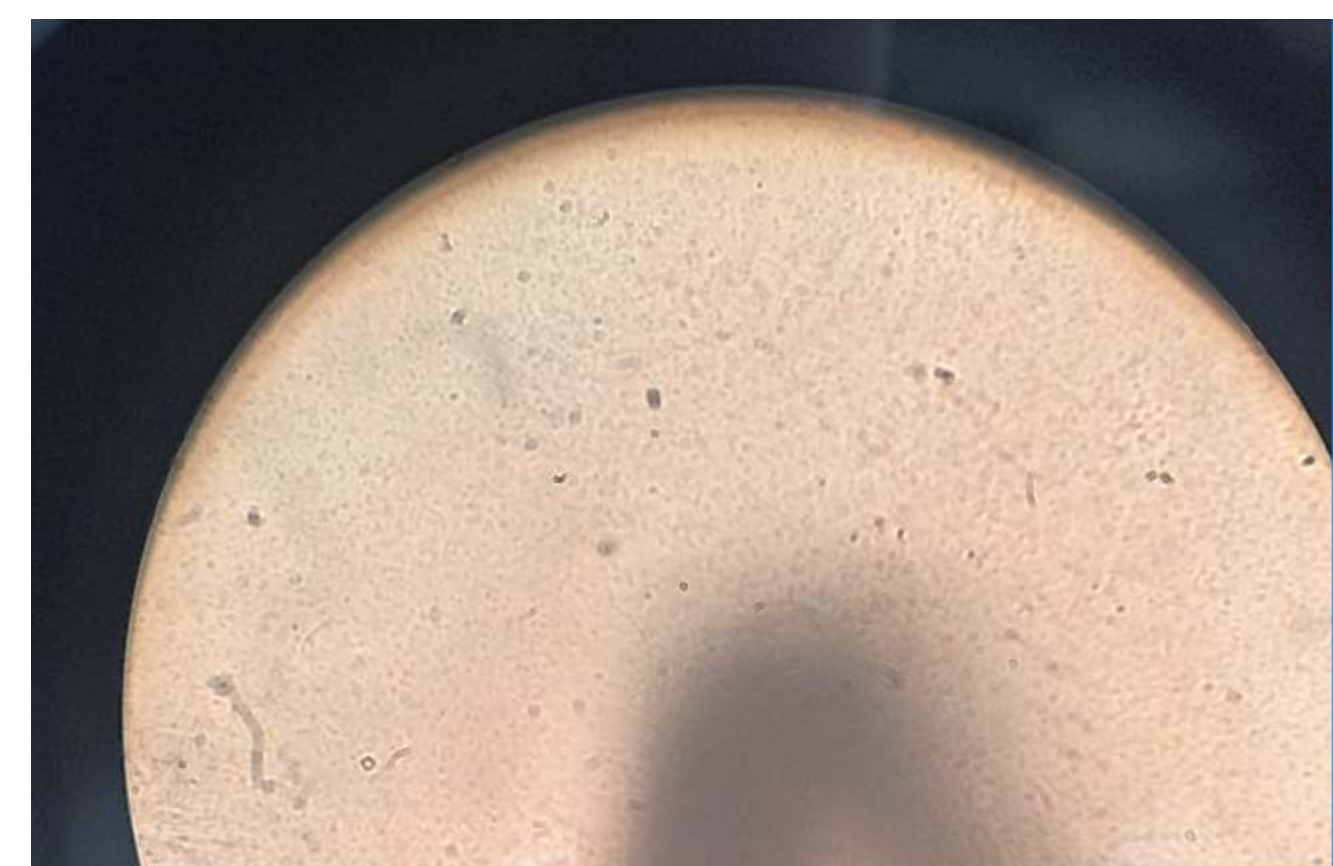


Fig6 Bacteria moving along the magnetic field direction.MTB motility is controlled

Discussion

We have made a very small mesh to create a path for the bacteria to move. With the controller magnetic field is created which the bacteria senses move along the path. The direction of the bacterial motility is well controlled, making them move in a selective path along the mesh

Conclusion

We focused on making an FPGA mesh for guiding the MTB by controlling the magnetic field generated by the mesh and implementing this idea for using in bioengineering applications like programmable drug delivery, cancer targeting and also in nanofabrication

References

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